Collaboration to Maximize Performance: *S&T Innovation Through Convergence*

Department of Defense Human Factors Engineering Technical Advisory Group Meeting 68
Aberdeen Proving Ground

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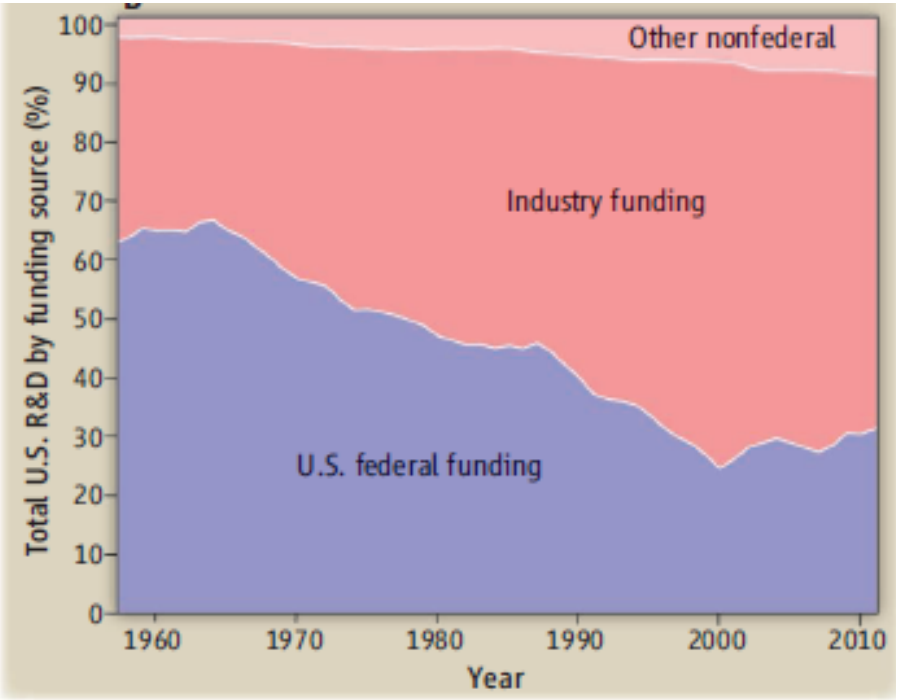
Overview

- **Challenge to S&T Innovation**
- **A Model For Maintaining and Advancing S&T Innovation**
- **The Role of Convergence in Applying this Model**
- **Enabling Convergence in the DoD S&T Ecosystem**
- **Example**
- **Summary**

Our Challenge

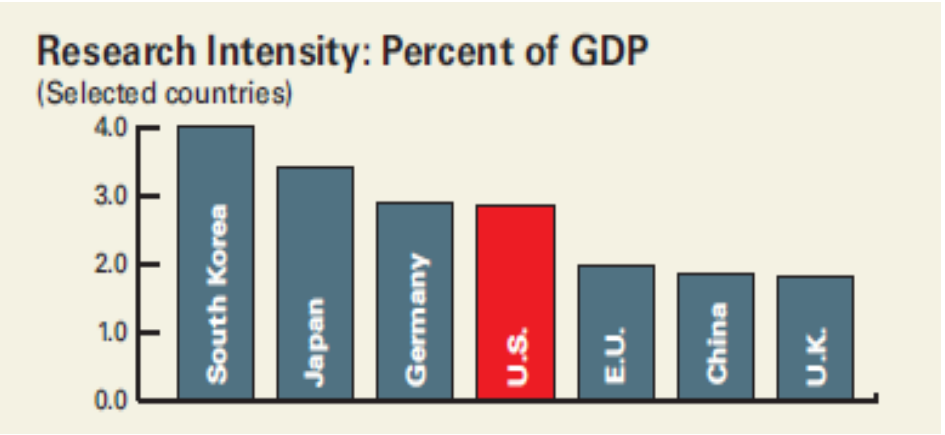
Driving innovation in a dynamic S&T environment

eral S&T funding is decreasing…



- Nature (2014) 507:297-299

…while our global S&T role is cont



- Science (2014) 343:718

Intensity: "the ratio of expenditures by an organization on research and development compared to their [bottom line]"

- "About.com Economics Glossary" Retrieved 04 May 2014

How do we maintain and advance our S&T

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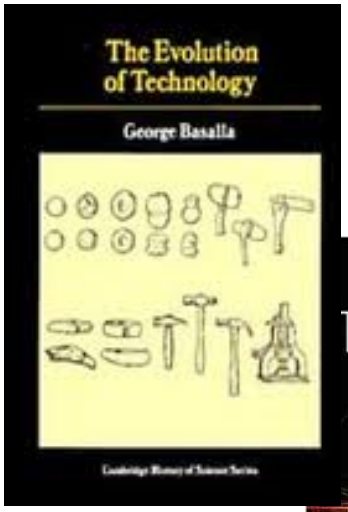
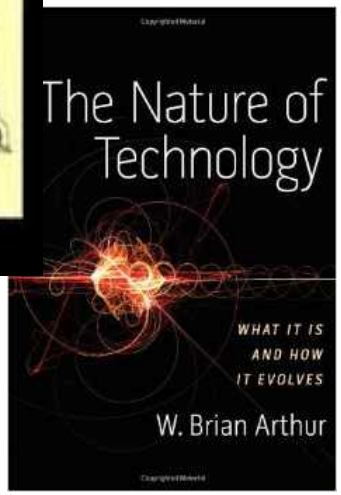
From Whence Cometh Innovation?

S&T innovation evolves much like organisms evolve…but with some differences



http://books.google.com/books/about/The_Evolution_of_Technology.html?id=e0psQgAACAAJ Retrieved 04 May 2014



http://tuvalu.santafe.edu/~wbarthur / Retrieved 04 May 2014

S&T Push

1. Identify new Phenomenon
2. Deepen these Phenomenon
3. Combine into new Phenomenon
4. Leverage / repeat as needed

Requirements Pull

INNOVATION

This model is typically running in the background

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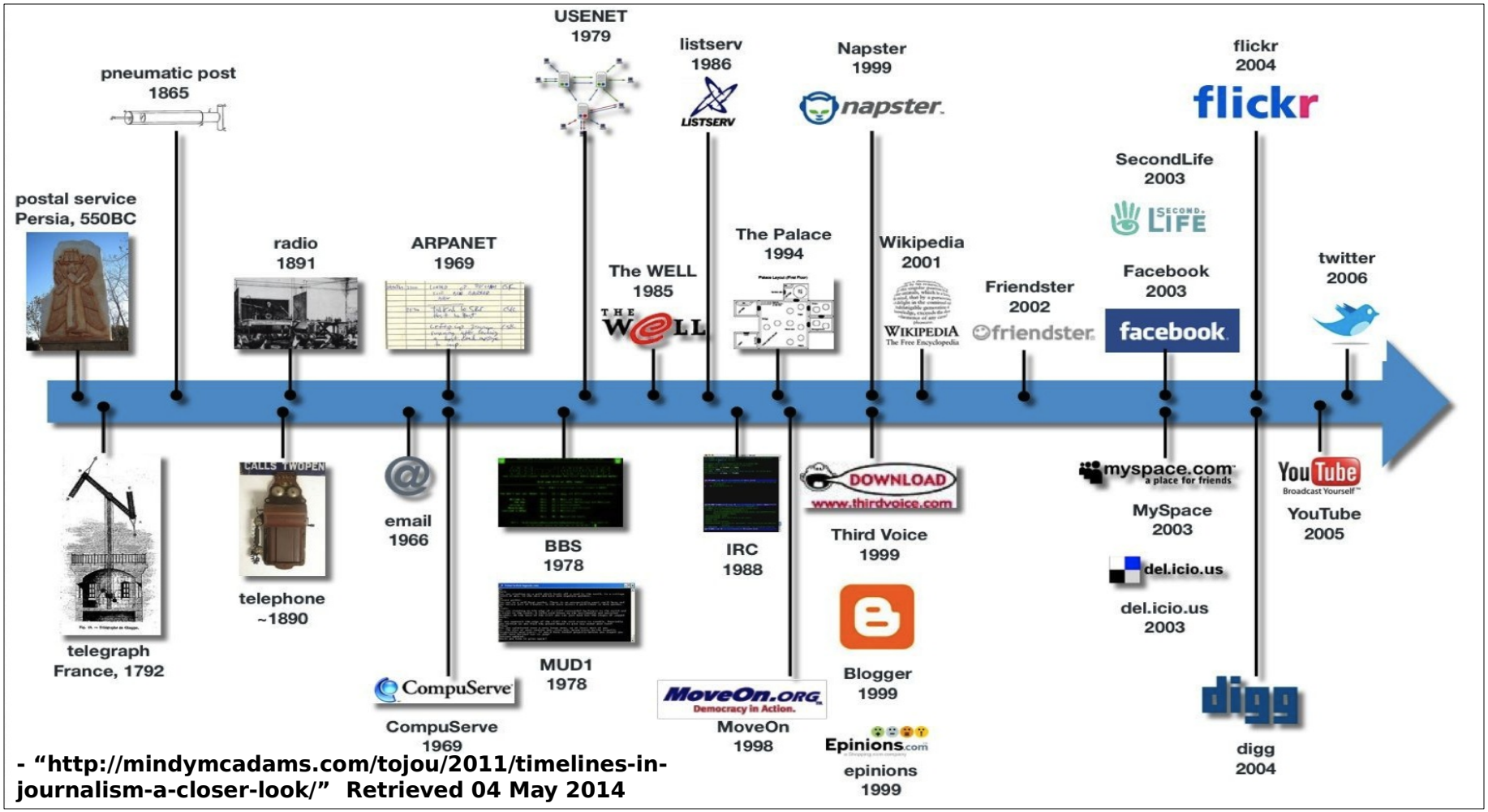
Example: Evolution of Social Media Technologies



- "http://mindymcadams.com/tojou/2011/timelines-in-journalism-a-closer-look/" Retrieved 04 May 2014

Where is the S&T push or the Requirements pull leading to innovation?

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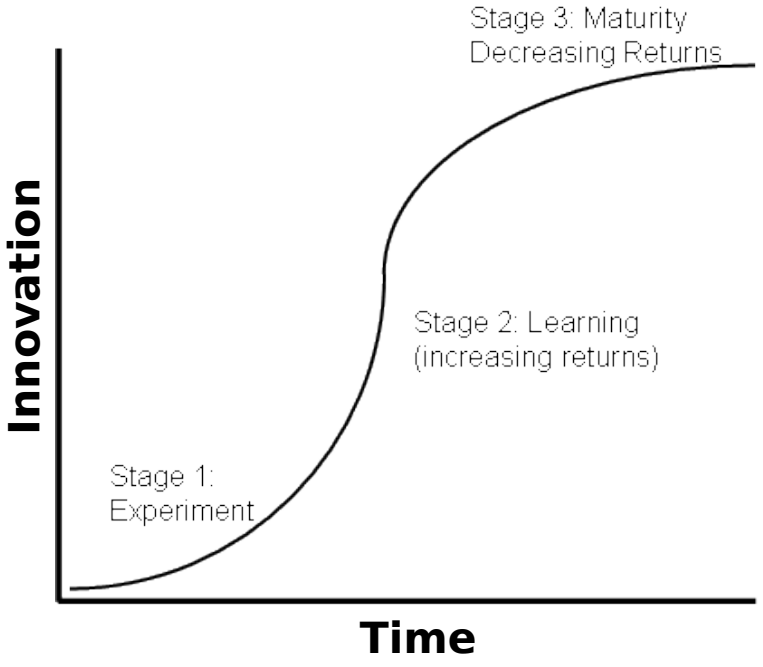
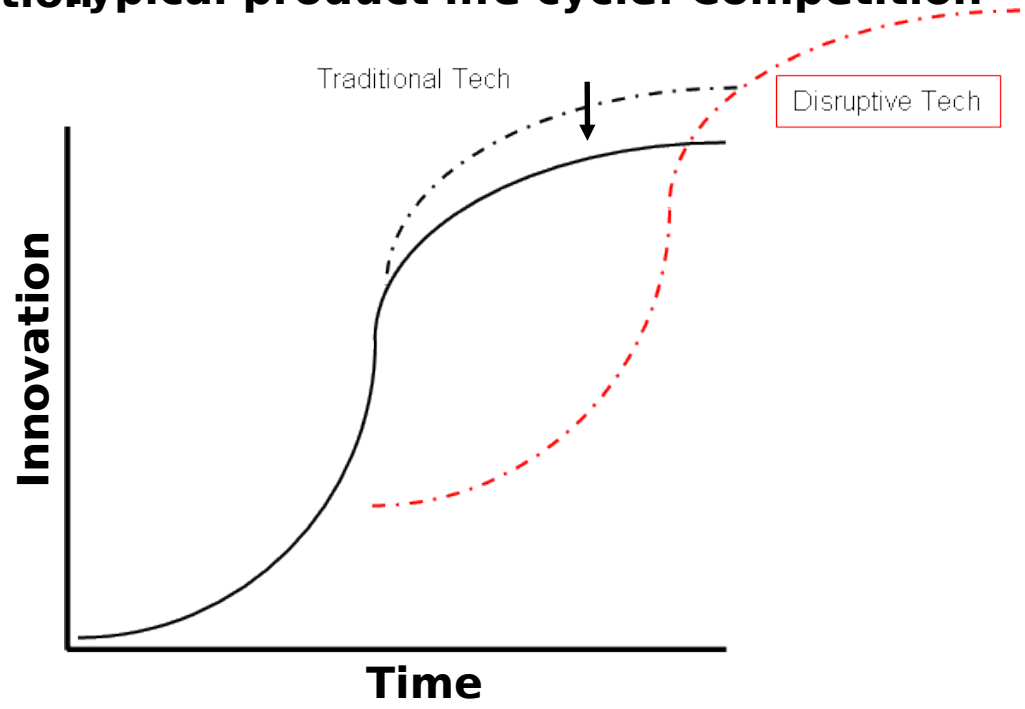
The Twist

S&T innovation is driven by advances in many different domains as well as by competition across these domains

Typical product life cycle: No competition



Typical product life cycle: Competition



Curves represent 20/20 hindsight; How do you predict which curve you are on?

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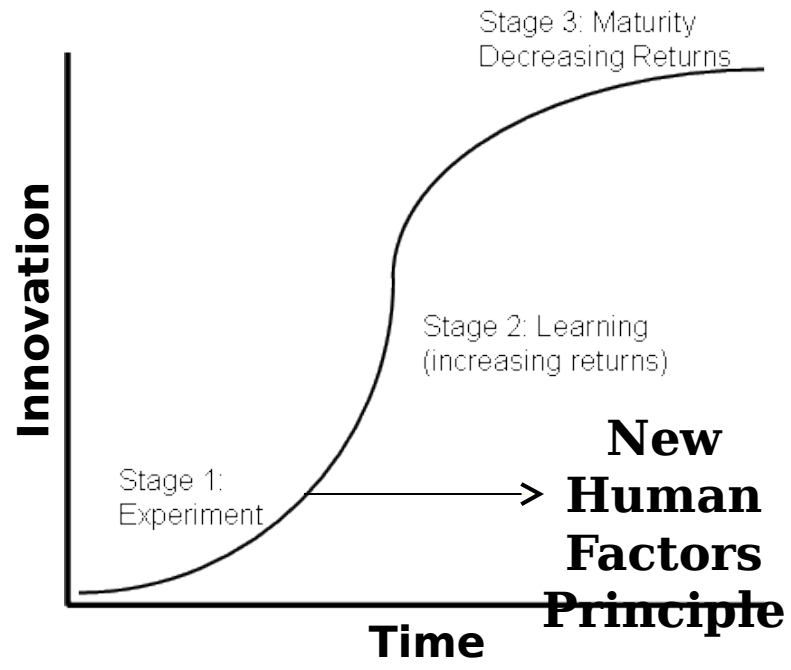
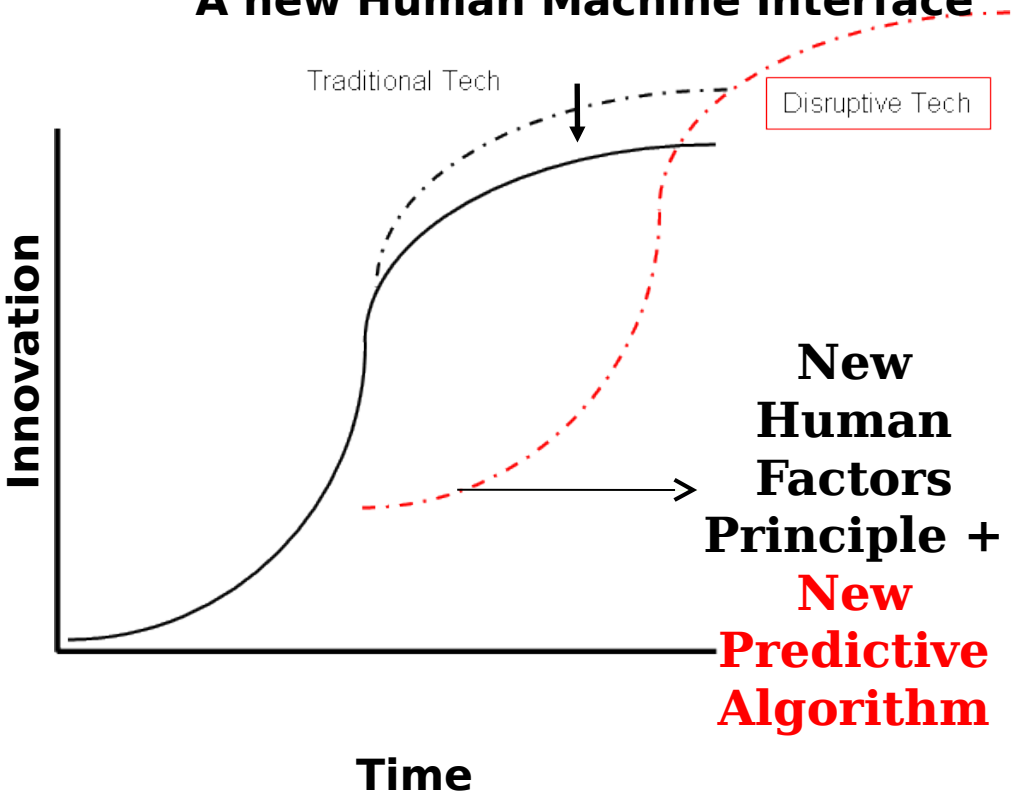
The Twist

An issue of disciplinary boundaries

A new Human Machine Interface



A new Human Machine Interface



Can we blur the boundaries to increase likelihood of innovation?

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Convergence

Improving the probability of new discoveries and innovative products

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
The Third Revolution:
The Convergence of the Life Sciences, Physical Sciences, and Engineering

"… the merging of technologies…disciplines…or devices into a unified whole that creates a host of new pathways and opportunities. Convergence [is] a blueprint for innovation…' (P. 4)

http://dc.mit.edu/sites/dc.mit.edu/files/MIT%20White%20Paper%20on%20Convergence.pdf
Retrieved 04 May 2014

Collaboration inspires innovation

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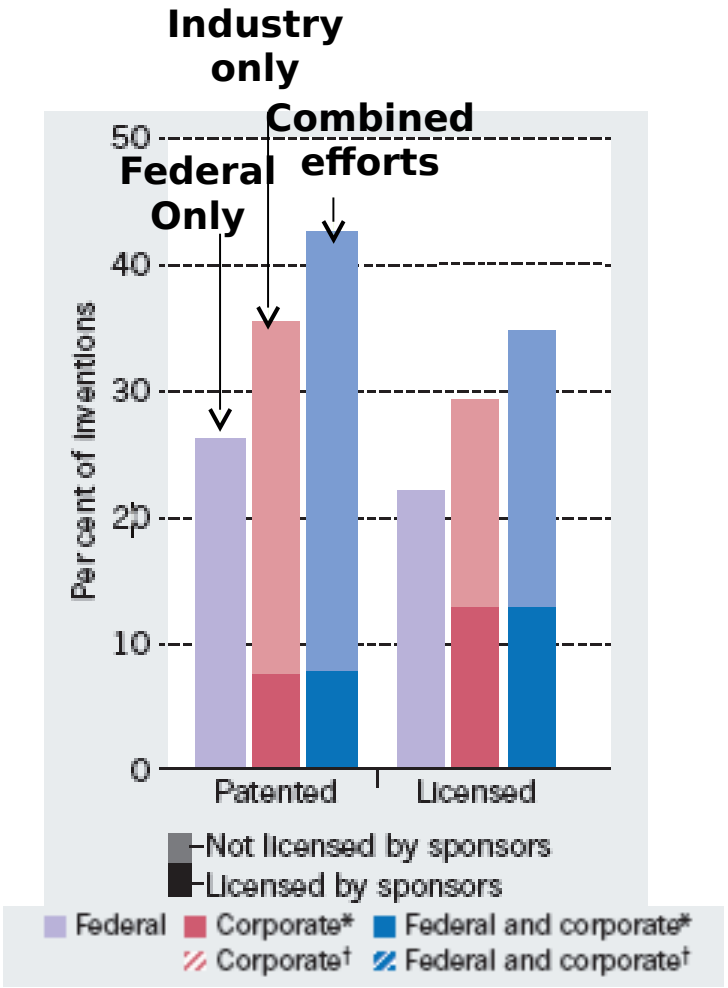
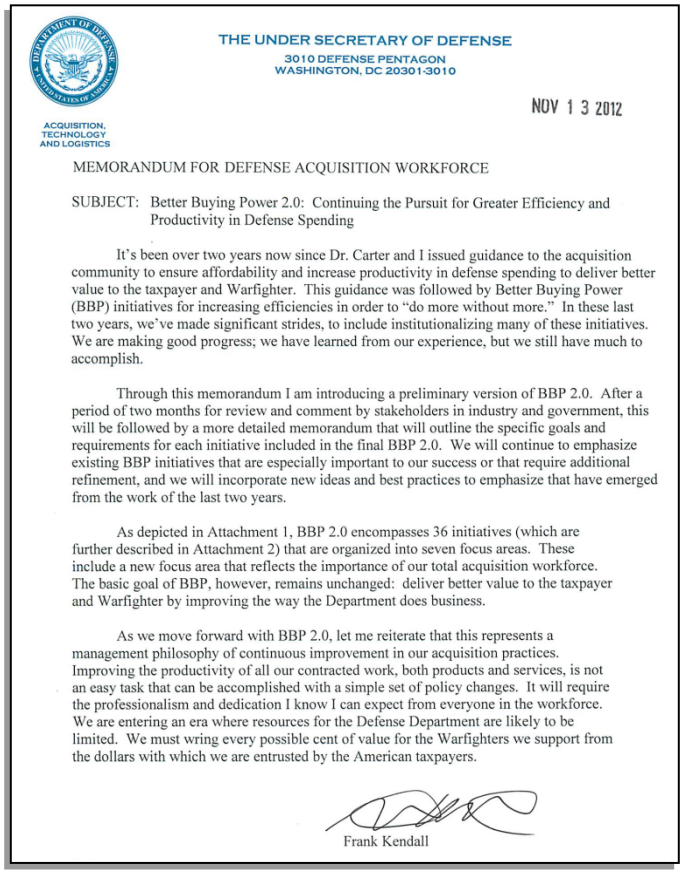
Convergence at Work



- Science (2013) 342:817-822

Better Buying Power 2.0



THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION, TECHNOLOGY AND LOGISTICS

NOV 13 2012

MEMORANDUM FOR DEFENSE ACQUISITION WORKFORCE

SUBJECT: Better Buying Power 2.0: Continuing the Pursuit for Greater Efficiency and Productivity in Defense Spending

It's been over two years now since Dr. Carter and I issued guidance to the acquisition community to ensure affordability and increase productivity in defense spending to deliver better value to the taxpayer and Warfighter. This guidance was followed by Better Buying Power (BBP) initiatives for increasing efficiencies in order to "do more without more." In these last two years, we've made significant strides, to include institutionalizing many of these initiatives. We are making good progress; we have learned from our experience, but we still have much to accomplish.

Through this memorandum I am introducing a preliminary version of BBP 2.0. After a period of two months for review and comment by stakeholders in industry and government, this will be followed by a more detailed memorandum that will outline the specific goals and requirements for each initiative included in the final BBP 2.0. We will continue to emphasize existing BBP initiatives that are especially important to our success or that require additional refinement, and we will incorporate new ideas and best practices to emphasize that have emerged from the work of the last two years.

As depicted in Attachment 1, BBP 2.0 encompasses 36 initiatives (which are further described in Attachment 2) that are organized into seven focus areas. These include a new focus area that reflects the importance of our total acquisition workforce. The basic goal of BBP, however, remains unchanged: deliver better value to the taxpayer and Warfighter by improving the way the Department does business.

As we move forward with BBP 2.0, let me reiterate that this represents a management philosophy of continuous improvement in our acquisition practices. Improving the productivity of all our contracted work, both products and services, is not an easy task that can be accomplished with a simple set of policy changes. It will require the professionalism and dedication I know I can expect from everyone in the workforce. We are entering an era where resources for the Defense Department are likely to be limited. We must wring every possible cent of value for the Warfighters we support from the dollars with which we are entrusted by the American taxpayers.

Frank Kendall

- **Incentivize Innovation in Industry & Gov't**
- **Promote Effective Competition**

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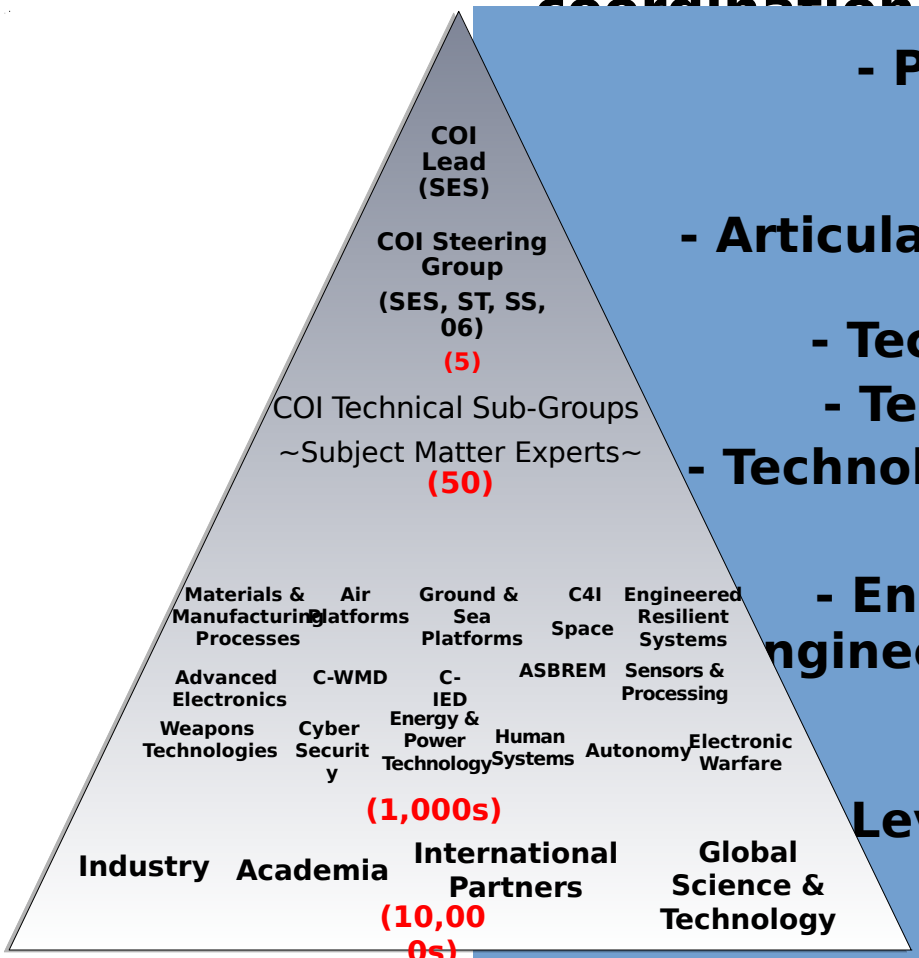
The Department's Long – term Strategy

Establish S&T Communities of interest (COIs) that serve as the "go-to" source for DoD S&T expertise, leadership and coordination



- Prioritizing Gaps and Opportunities
- Articulating Military Impact
- Technical Coordination
- Technology Roadmaps
- Technology Goals and Gaps
- Engaging Scientists & Engineers across DoD Labs
- Leveraging global S&T Community

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EXAMPLE 1: NATURAL HUMAN MACHINE INTERFACE

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Natural Human-Technology Interactions

<u>Goal:</u> Optimal integration of humans with their technologies for mission effectiveness

These Marines will smoothly move through this building…without speaking a word

http://www.navy.mil/management/photodb/photos/120307-N-SD300-041.jpg
Retrieved 05 May 2014

Need to replicate this for human–technology interactions

- Screen Shot from Department of Defense's Human Performance Training and BioSystems Directorate Video

<u>Benefits:</u> Faster responding and more accurate "hybrid teams" with less manpower

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Natural Human-Technology Interactions

- DoD UAS Roadmap 2005-2030, http://www.fas.org/irp/program/collect/uav_roadmap2005.pdf Retrieved 05 May 2014

Allow Warfighters to focus on their primary mission, not on operating their tools

Today,

Human – Technology interactions use interfaces that:

- **Do not support bi-directional communication**
- **Do not learn with experience**
- **Require specialized operator selection and training**

- **Easy to use**
- **Limited control**

- **Hard to use**
- **Ample control**

- DoD UAS Roadmap 2005-2030, http://www.fas.org/irp/program/collect/uav_roadmap2005.pdf Retrieved 05 May 2014

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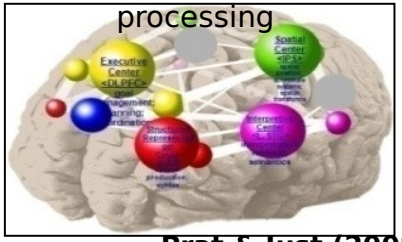
Converge Multiple Domains

Focus on one outcome: natural human-technology interactions

HUMAN | **MACHINE**

Computational Modeling

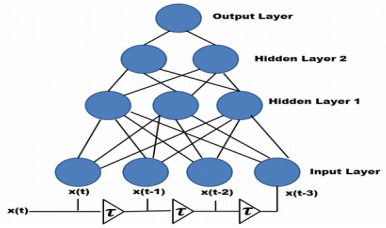
Simulate human information processing



- **Prat & Just (2008)**

Context Inference

Reason about a situation



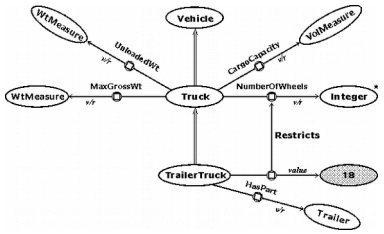
Neuroscience

Brain's operating

- **Luu et al (2009)**

Knowledge Systems

Store/search for information

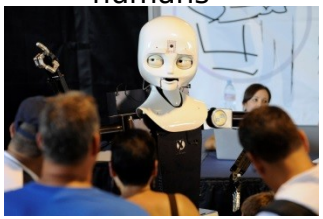


Evolutionary Biology / Social Psychology

Cognitive and Behavioral operating principles

Computer Understanding

Lays groundwork for reasoning about a situation, working with humans



http://commons.wikimedia.org/wiki/

Retrieved 04 May 2014, originally released by US Navy. File:US_Navy_100531-N-7676W-075

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ACTION

Objective: Engage DoD Labs, S&T Offices, Industry and Academia to ensure alignment across research efforts and requirements

Plan:

1. **Annual NDIA Engagement: Share OSD's views, component level funding opportunities, identify some of the program managers focusing heavily on new areas**
2. **Annual HS CoI – engaged Workshop: Invite Component PMs, leading Academicians, and innovative businesses (including small businesses) to partake of more in-depth conversations focusing on understanding current and future trends / requirements**
3. **Expand DoD Innovation Marketplace**
    1. Consider a quarterly review of the site including content, number of visitors etc
    2. Consider a quarterly webcast, published in fedbizops, featuring S&T leaders from OSD and the Components discussing topic of interest

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Summary

- **Maintaining and advancing our Nation's S&T innovation edge will require new ways of framing S&T**
- **Increasing the likelihood of innovative thinking can be achieved in part by through "Convergence" across disciplines…and organizations / agencies**
- **Convergence is not THE solution but it should provide a means for injecting new ideas and new ways of thinking into the S&T process**

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Backup

EXAMPLE 2: ADAPTIVE TRAINING

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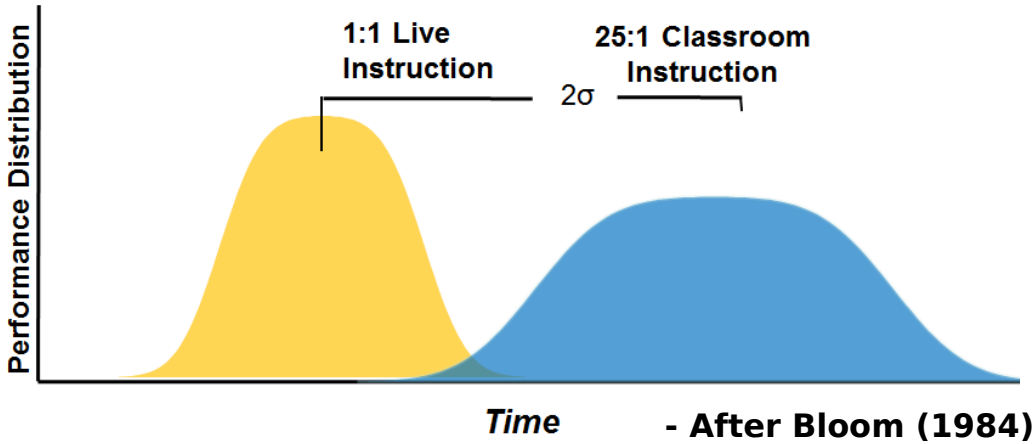
Individualized Training for Accelerating Expertise Development

Goal: Digital technologies that replicate the very best instructors' techniques

Individualized instruction has significant benefits…but is infeasible



- After Bloom (1984)

Need to 'bottle' this instructor's

http://commons.wikimedia.org/wiki/File:US_Navy_081216-N-9995B-003_Engineman_1st_Class_Gabino_Ramirez_provides_classroom_instruction_on_small_boat_maintenance_to_Panamanian_sailors_during_a_Southern_Partnership_Station_training_session.jpg Retrieved 04 May 2014, originally released by US Navy ID 081216-N-9995B-003

Benefits: Reduce performance variability and quickly prepare to outperform adversaries

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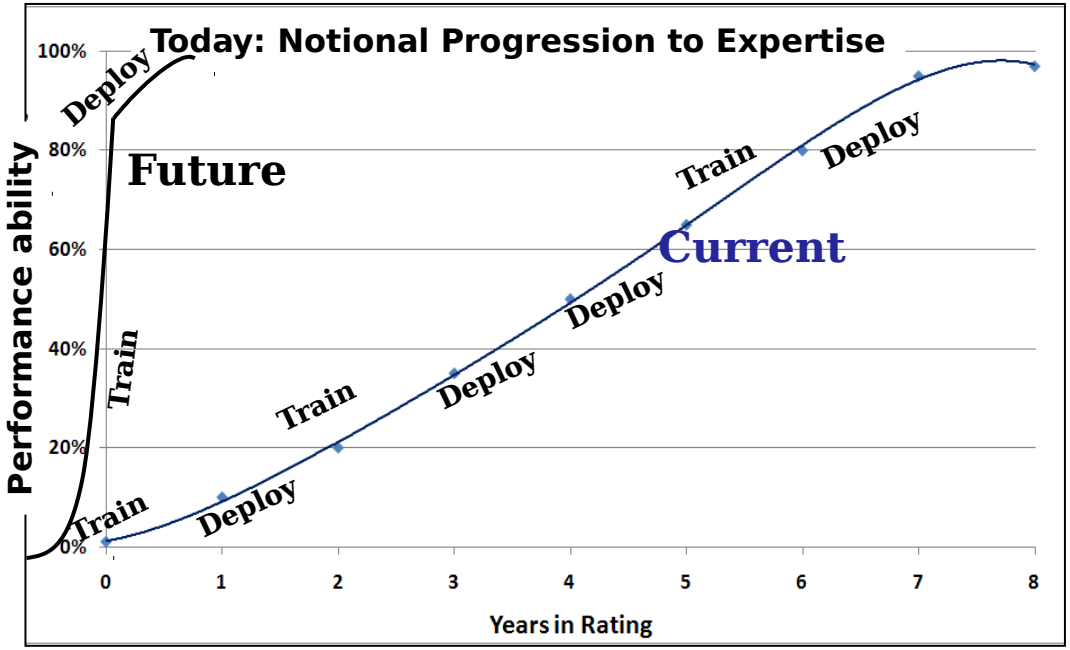
Individualized Training for Accelerating Expertise Development

Focus S&T to break the current 'vicious' cycle of training



Drive Advances In:
• Affective Computing
• Learning Sciences
• Cognitive Modeling
• Knowledge Frameworks
• Human Performance Assessment
• Natural Language Dialogue
• Human Machine Interfaces
• Remediation

Keep pace with rapidly changing combat environment

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2. **Annual HS CoI – engaged Workshop: Invite Component PMs, leading Academicians, and innovative businesses (including small businesses) to partake of more in-depth conversations focusing on understanding current and future trends / requirements**
3. **Consider Annual Special Event at IITSEC with Industry and OSD leaders to discuss future trends**
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